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No. 84-8

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

FOREST PEST MANAGEMENT

STATE & PRIVATE FORESTRY

INTERMOUNTAIN REGION

3420
Report No. 84-8
October 1984

DETECTION AND DISSEMINATION OF FOREST PEST DATA IN THE INTERMOUNTAIN REGION UTILIZING AERIAL DETECTION SURVEYS AND COMPUTER MAPPING SYSTEMS

by

Ron L. Beveridge
and
K. Andrew Knapp[1]

ABSTRACT

The Intermountain Region, Forest Pest Management staff, annually conducts aerial detection surveys over 13.5 million acres of forested lands to monitor visible vegetation injury caused by forest pests. Surveys provide information concerning location of pest activity, probable pest involved, degree of defoliation or number of trees killed and acreage involved. Surveys are conducted, mapped information is summarized, and maps are duplicated for 78 districts on 16 National Forests, and all concerned state, private and other federal land managers.

Information from the surveys is digitized into a computer automated mapping and geographic information system which outputs data summaries and duplicates survey maps. Hardware used includes the Hewlett Packard 9845T desktop computer, digitizer and plotter. The software package involves 14 different programs developed by Forest Pest Management personnel. Compared to the previously used manual methods, this system significantly reduces manpower requirements, decreaes time to disseminate information, and improves accuracy of data summation.

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[1] Biological Technicians, USDA Forest Service, Intermountain Region, Forest Pest Management, Boise Idaho

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240 W Prospect Rd
Fort Collins CO 80526

INTRODUCTION

Forest pests are active throughout forests of the Intermountain Region. Methods used to detect and monitor these pests depend largely upon how the pest affects a host and how these effects are displayed. Aerial detection surveys (ADS) are used to detect and monitor highly visible injury such as that caused by defoliating insects and bark beetles and are conducted annually to monitor previously identified insect infestations or to identify new ones. Following are discussions of how ADS are conducted, how information from them is summarized and how information is or can be used by land managers in the Intermountain Region.

AERIAL DETECTION SURVEYS

As directed in section 3412.1 of the Forest Service Manual, ADS are conducted annually over selected portions of the Intermountain Region to detect and monitor aerially observable insect or disease caused injury to forest vegetation. Symptoms of forest pathogens are difficult to detect with the exception of some needle diseases, very heavy dwarf mistletoe infections and large openings caused by root rots. Most aerially visible vegetation injury is attributed to bark beetles and/or defoliating insects. A skilled aerial observer can detect visible vegetation injury caused by these pests, estimate the degree of injury to host trees, determine probable pest involved and plot this information on a map with reasonable accuracy.

In addition to the annual ADS, special aerial surveys may be conducted to monitor specific problem areas which could not be intensively monitored during the annual survey.

Planning ADS

All national forests in Region 4 are contacted during April of the survey year to identify high priority ADS areas. Forest inputs are combined with Forest Pest Management (FPM) priority areas, such as current insect infestations or areas with a high potential of becoming infested, to develop a regionwide survey schedule. Generally, the ADS covers major commercial timber production areas, National Recreation Areas, administrative sites and ski areas. Low priority areas not surveyed unless specifically requested are: administrative set-asides, wilderness areas, alpine zones and extensive blocks of pinyon-juniper. Low priority areas may be surveyed on an alternate year basis.

ADS are conducted from late June through early September and insofar as possible are scheduled to coincide with optimum injury symptom expression of major forest insects (Table 1). Since symptoms are expressed earlier in southern latitudes than in northern latitudes surveys are normally initiated in the southern most forests of the Intermountain Region and progress northward on a forest by forest basis.

Table 1 - - STANDARDIZED CODES, COLORS, AND LABELS USED FOR MAPPING FOREST PESTS IN THE INTERMOUNTAIN REGION

INTERMOUNTAIN REGION AERIAL DETECTION SURVEY
PEST CODES AND LEGEND INFORMATION

COLOR CODE	FOREST PEST	HOST SPECIES	OBSERVATION PERIOD	SYMBOLS AND LABELS	COMPUTER CODES
RED	Mountain Pine Beetle	Lodgepole Pine	June 15 - August 1	*L o10L and polygons	11
		Ponderosa Pine	July 1 - August 15	*P o10P and polygons	12
		White Bark Pine	July 15 - August 30	*X o10X and polygons	13
		Mixed LP and PP	July 1 - August 30	*L+P o10L+P and polygons	14
PURPLE	Douglas-fir Beetle	Douglas-fir	MAY 1 - July 15	* o10 and polygons	21
ORANGE	Ips species	Ponderosa Pine	June 15 - Oct. 15	*I o10I and polygons	31
		Lodgepole Pine	June 15 - Oct. 15	*I o10I and polygons	31
	Tussock Moth	Douglas-fir	June 15 - July 15	Polygons with TM	L=67 M=68 H=69
		Ceanothus	June 1 - July 15	Polygons with WTM	70
BROWN	Western Pine Beetle	Ponderosa Pine	July 15 - August 15	* o10 and polygons	41
	Fir Engraver Beetle	Grand & Subalpine Firs	July 1 - August 15	*F o10F and polygons	52
	Larch Casebearer	Western Larch	June 15 - July 15	Polygons with Lc	L=64 M=65 H=66
	Pine Butterfly	Ponderosa Pine	June 15 - July 15	Polygons with Pb	72
	Sawflies (all)	All species	July 1 - Oct. 30	Polygons with Sf	73
	Needle Miner	Ponderosa Pine	July 1 - August 15	Polygons with Nm	74
	Aspen Tortrix	Aspen	July 1 - Oct. 30	Polygons with Asp	75
BLUE	Western Spruce Budworm	True Firs, Spruce, Douglas-fir	June 20 - August 15	Polygons	L=61 M=62 H=63
GREEN	Spruce Beetle	Spruce species	July 15 - Oct. 30	* o10 and polygons	51
	Dwarf Mistletoe	Lodgepole Pine	May 1 - Nov. 30	Polygons with LP	82
		Ponderosa pine	May 1 - Nov. 30	Polygons with PP	83
		Douglas-fir	May 1 - Nov. 30	Polygons with Df	84
		Larch	May 1 - Nov. 30	Polygons with L	85
BLACK	Subalpine Fir Complex	Subalpine Fir	June 1 - Sept. 1	Polygons with SAF	81
	OTHER DAMAGE				
	Spray Areas			Polygons with SPRAY	91
	Omitted Areas			Polygons with OMIT	92
	Chemical Thin			Polygons with CHEM	93
	Unknown Mortality			Polygons with U.M.	94
	Unknown Defoliation			Polygons with U.D.	95
	Non-Pest			User Defined Label	98

Conducting Aerial Surveys

Surveys are conducted on a drainage by drainage basis from fixed wing aircraft at 500-1500 ft above ground level. Depending on forest or survey area size, pest activity and weather conditions, each forest in the region requires from one to seven days to survey.

Extent and severity of visible vegetation injury and pest identification are plotted on sketchmaps which may be 3/8 in or 1/2 in per mi forest base maps, 7-1/2 min or 15 min quadrangle maps, or aerial photos of various scales. Location of injury caused by a specific pest is identified by color coded symbols (dots, circles or polygons) and/or labels (Table 1). Since color codes and symbols have been used consistently in Region 4 since 1964 current and historical ADS data can easily be compared.

Small or large groups of even-aged mortality or totally discolored trees (faders) often characterize bark beetle activity. Small bark beetle infestations are plotted on the sketch-map as dots (less than 10 fading trees) or small circles with the number of faders, while larger infestations are delineated into polygons and are plotted with estimates of the total number of fading trees being noted inside them. Perimeters of extremely large infestations, covering thousands of acres, are likewise delineated but the number of fading trees per acre is estimated and recorded inside the polygon. Subsequent ground evaluations may be conducted to verify pest identity and accuracy of mortality estimates.

Injury symptoms attributed to defoliating insects (defoliators) or needle diseases range from being barely visible to very obvious. Generally at least 15% of the tree crown must be defoliated or discolored before the injury is aerially detectable. Defoliation intensity is based on the percent of aerially visible current year defoliation observed in the crowns of susceptible conifers. Defoliation is classified as being light, moderate, or heavy in areas where the majority of the tree crowns average less than 30%, between 30% and 70% or more than 70% defoliation respectively.

Vegetation injury symptoms which cannot be readily attributed to specific pests are plotted on sketch-maps as being of questionable cause. Location of such injury may also be entered into the aircraft's LORAN-C navigational system which provides a digital readout of the aircraft's geodetic (latitude and longitude) position within 600 ft. These geodetic coordinates are a valuable aid in pinpointing the ground location during followup ground evaluations to determine causal agents.

When ADS and followup ground evaluations of each forest or survey unit are completed, information is replotted onto a single 1/2 in or 3/8 in per mi forest base map, which is then digitized for data summation and map reproduction.

PROCESSING ADS DATA

Computer automated/aided mapping (CAM) and geographic information systems (GIS) have been tested by the Methods Application Group (Young 1977, Young 1979) for possible application in the analysis of ADS data. Although several systems were practical for FPM use, all required computer hardware unavailabe to the FPM staff in Region 4.

In 1979 the Boise National Forest acquired a Hewelett Packard (HP) 9845T desktop computer, an HP-9874A digitizer, an HP-9872A plotter and an HP-7906 disc drive. This system was made available to FPM which shares office space with the Boise National Forest. We have developed for use with this available hardware and a newly aquired HP-7580B plotter, a software package consisting of fourteen separate computer programs (Appendix) to summarize ADS information and reproduce ADS maps, operations previously accomplished manually.

Digitizing Survey Data

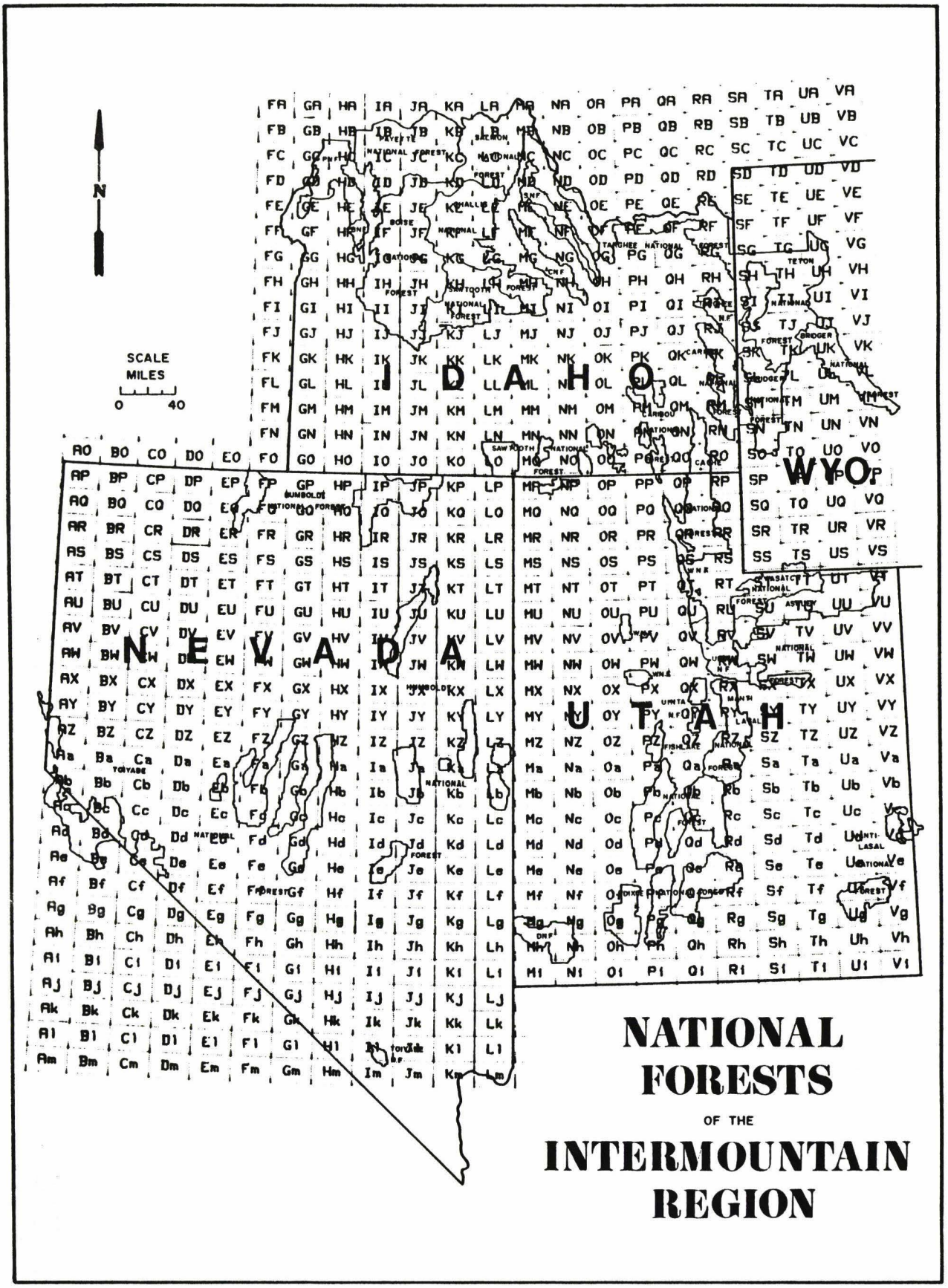
The basic step in processing ADS data is digitizing the ADS information. Digitizing is the conversion of graphical information to digital X and Y coordinates and storing this data on magnetic disc or tape.

Digitizing of survey maps for selected forests in southern Idaho was initiated during 1980 and 1981 to test the speed and accuracy with which the data could be computed. The actual time required to digitize an ADS map took less time than was required to manually calculate the number of faders and acreage affected. Data summaries produced from the digitized data were constant and accurate. Maps were manually duplicated.

Since the available HP-9874A digitizer and the HP-9872A plotter have small (12in x 18in) active working surfaces only sections of maps could be accomodated. As a result the region was divided into approximately 750 rectangular map sections. Each map section is comprised of two US Geological Survey (USGS) 15 min quadrangle maps covering approximately 450 square miles and is identified by two alpha characters (Figure 1). Map sections are 30 min in width (longitude) and 15 min in height (latitude), with the outer corners coinciding with those of two adjoining 15 min USGS quadrangle maps. Although several methods were initally considered to section forest maps into smaller units, the above method was chosen since most forest maps are printed with small reference marks at the same 15 min intervals used for USGS quadrangle maps.

Geodetic coordinates for each map section corner were converted from degrees and minutes to meters in universal transverse mertcator (UTM) coordinates using GEOM*DTIS.SIMCORCON a computer program available at the Fort Collins Computer Center. Conversion to UTM coordinates was necessary since ground distance between degrees of longitude varies with latitude. The UTM coordinates, however, represent points on the curved surface of the earth as distances from a straight X and Y axis enabling the mapping system to determine the size, location and distance between any map sections in Region 4. These coordinates, were placed in a data file on the HP system and are accessed as needed.

Figure 1 - - LOCATIONS AND CODES OF ADS MAP SECTIONS FOR THE INTERMOUNTAIN REGION



Prior to digitizing ADS information map sections and Forest Service ranger district boundaries are drawn on the ADS map to aid the operator in defining boundaries for data files. Maps are then attached to the digitizer with tape to prevent shifting and the digitizing process is begun.

Data file names are created for each map section at the beginning of the digitizing process either by the operator or the digitizing program. Data file names consist of, in the following order, the first letter of the forest name, the last two digits of the survey year, the ranger district number, and the two alpha characters for the map section e.g., B841AA. The operator may create and enter the data file name when prompted by the program, or, if no name is entered, the digitizing program will request the necessary information from the operator and construct the data file name. The data file name is checked against the mass storage device directory, by the digitizing program, to prevent duplication of names and to prevent redigitizing map sections.

After the data file name has been entered, reference points for each map section must be digitized in order to correctly locate all other geographic information within the map section. These points are the southwest, and northeast corners of each map section.

Scale of the ADS map being digitized is required by the digitizing program for accurate computation of polygon area. It may be entered in one of three ways depending on which option the operator chooses. The scale may be automatically calculated by the digitizing program by comparing the digitized distance between reference points against the actual ground distance stored in the UTM coordinate file; it can be calculated by the program from any two points that can be digitized on the map if the operator knows the actual on ground distance between them; or it may be entered directly from the CPU keyboard as a decimal value relative to in per mi, e.g. .5 equals 1/2 in per mi.

After the map section is properly aligned on the digitizer, and the necessary location and scale information are entered, the ADS information may then be digitized. Pest data is normally digitized as either individual points or polygons. The data input mode (point, polygon, line) is selected by the operator by depressing program defined function keys on the CPU keyboard.

Individual points are used primarily to record the location of small groups of fading trees often associated with bark beetle activity. However by using the non-pest code, 98, individual points may also be used to identify specific locations for a variety of purposes. For bark beetles; point location, number of faders, and the computer pest code (Table 1) are all recorded in one process. To digitize information from an individual point the number of faders (no value is needed for centers with less than 10 faders) and the appropriate pest code are first entered on the digitizer keyboard, then the point location is entered with a digitizing sight. This location, relative to the reference points is converted into X-Y coordinates and placed with the pest code and number of faders into an internal data file in the CPU. The location is also graphically displayed on the CRT with a asterisk (*) or circle (o) and the appropriate symbol. Standard labels (Table 1) and the number of faders entered are also displayed on the CRT to aid the operator in determining if any errors have been made during the digitizing process.

Once a pest code has been entered it will become the default code and need not be reentered if the same pest is being continually digitized. For succeeding locations of the same pest the operator may simply enter the number of faders and digitize the point location. Location, number of faders and pest code will be recorded in the data file as if the code were entered on the digitizer keyboard. However, only the color coded symbol and number of faders will be plotted on maps. Additional labels normally plotted for that pest will be omitted, e.g. *L will be plotted as *. This is a useful feature when digitizing multiple infestations in a small area where labels for each point would become confusing. The ability to delete a label (but not numbers of trees) can be used at any time by entering a negative value when a pest code is entered on the keyboard.

The digitizing program is also used for polygons by depressing the polygon function key on the CPU keyboard which shifts the program from a point mode to the polygon mode. To begin digitizing each polygon a special key (key Fa) on the digitizer keyboard must first be depressed. The CPU will then place a code in the data file indicating the start of a polygon. The operator must then enter the pest code and number of faders (for beetle codes only) and digitize a location, in or near the polygon, where the appropriate label and/or the number of faders will be displayed. The polygon boundary is then digitized by continuously depressing the the digitize key on the digitizer sight while tracing the polygon boundary. As the operator approaches the beginning point a tone will be sounded. Tone intensity increases with nearness to the starting point. When the operator closes the polygon, by depressing key Fb the digitizing program will adjust for closure errors, compute the acreage of the polygon, and store the information in the data file. This process is repeated for each polygon digitized. As with point locations the last pest code entered becomes the default code until a new code is entered on the digitizer keyboard.

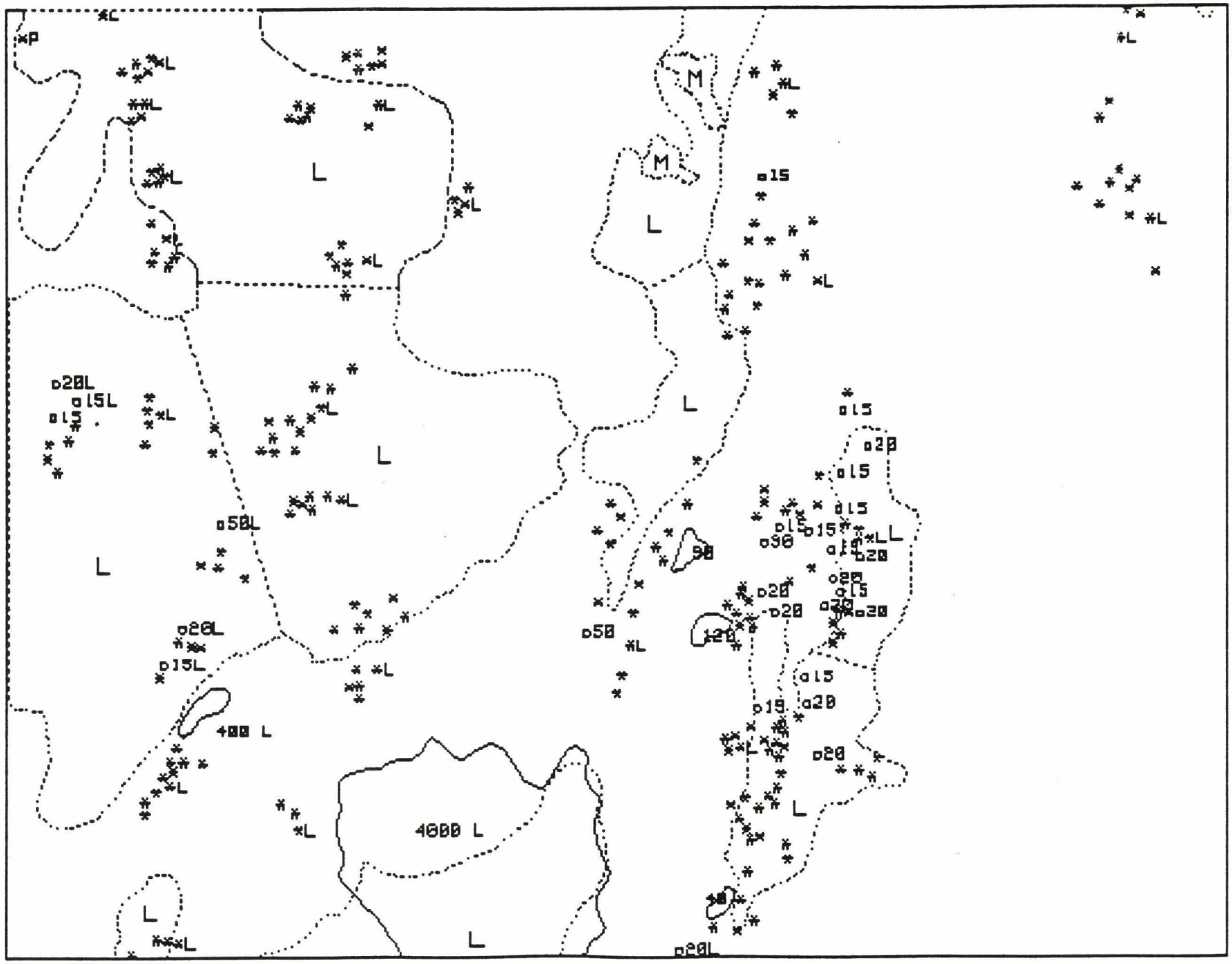
Data entry errors that occur during the digitizing process can be deleted by the operator if detected immediately after being digitized. Removing errors from the data file and the CRT is accomplished by pressing the appropriate mode key while depressing the shift key on the CPU keyboard. This will remove the polygon, the line being digitized, or the previously digitized point and any associated labels from the data file and the CRT simultaneously. Error removal is limited to the most recently digitized point, polygon or line. Errors not deleted as indicated must be corrected later using an edit program.

After pest data is digitized the information is stored on the designated mass storage device under the assigned file name and a thermal print of the graphics display on the CRT (Figure 2) is automatically produced. This reproductoin of the digitized data contains the data file name at the top and should be filed by forest and year to provide a quick reference to digitized information in the magnetic data files.

Editing digitized data

After being digitized an edit copy of the information is plotted on the HP-7580B drafting plotter and compared visually to the original ADS map. Map section boundary lines are also plotted on the edit map to aid the operator in locating specific map sections. Errors are corrected with an edit program before any data summaries are compiled or final maps are produced.

Figure 2 - - GRAPHICAL DISPLAY OF DIGITIZED PEST INFORMATION ON THE COMPUTER SCREEN


M
M
L
L
L

If miscoded, duplicated or missing information is discovered on the edit map, the appropriate map section data file is identified and digitized information is graphically displayed on the CRT. Next to each label, data file line numbers are displayed. Line numbers for erroneous data are identified and entered into the edit program. The edit program locates the point or polygon on the CRT and identifies it with a blinking pointer. The operator is allowed to verify that the correct point or polygon has been located before the information is changed in the data file. Appropriate changes are then entered when asked to do so by the program.

Summarization of survey data

Digitized data are summarized after editing is completed and corrections have been made. The summarization program automatically locates all data files for a specified forest and year. Acres of light, moderate, and heavy defoliation as well as total acres defoliated are computed for each defoliating insect. Bark beetle information is summarized by pest code, number of acres infested, number of mortality centers, and number of faders.

Acreages of both polygons and point locations are summarized. Polygon acreages are calculated by the digitizing program as the polygon is being digitized and are stored in the data file. The summarization program reads these values and totals them by pest. Acreage values for point locations are averages estimated by the experience of the Region 4 aerial observer backed by ground checks. These averages, 5 acres for 3-10 tree points and 10 acres for 10-100 tree points, are encoded into the summarization program and are added to the acreage summary for a specific pest code each time a point location is encountered in a data file.

Numbers of trees injured are summarized only for bark beetles. Values summarized are the number of faders entered during the digitizing process as total trees for all polygons and points where a number of faders was entered. In large polygons where the number of faders is entered as trees per acre, the summary program converts this value to total trees. For the 3-10 tree points the summarization program uses an average value for the number of faders. A value of 7 has been subjectivly selected for all bark beetle codes except western pine beetle where a value of 3 is used. These average values have been encoded into the summarization program and are automatically added, by pest code to the totals as 3-10 tree points are encountered in data files.

Data summaries can be displayed on the CRT and/or printed on thermal or wide carriage printers. Regardless of the device chosen, all output is formated as in Figure 3. Summaries for each district on a selected forest are listed first and include totaled values for each pest or pest/host combination detected. Bark beetle listings contain the common name of the beetle and host (if not apparent), total number of faders (dead trees), acres infested and number of individual point locations and polygons detected. Defoliating pests are listed by common name and total number of acres infested. Where defoliation intensity is recorded, number of acres in each defoliation category as well as total acres of defoliation are listed. Forest totals are printed following the district listings.

Figure 3 - - COMPUTER GENERATED SUMMARY OF 1984 AERIAL DETECTION SURVEY INFORMATION FOR THE EMMETT RANGER DISTRICT AND BOISE NATIONAL FOREST

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1984 A.D.S. EMMETT RANGER DISTRICT

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COMPILED 09/26/84

Mountain Pine Beetle (lodgepole)
Total number of dead trees 266
Area of mortality 190 acres
Number of mortality centers 38

Douglas-fir Beetle
Total number of dead trees 7
Area of mortality 5 acres
Number of mortality centers 1

Western Spruce Budworm defoliation:
Acres of light defoliation 22922
Acres of moderate defoliation 48494
Acres of heavy defoliation 73972
Total acres of defoliation 145389

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1984 A.D.S. BOISE N.F. TOTALS

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COMPILED 09/26/84

Mountain Pine Beetle (lodgepole)
Total number of dead trees 13558
Area of mortality 24347 acres
Number of mortality centers 713

Mountain Pine Beetle (ponderosa)
Total number of dead trees 458
Area of mortality 265 acres
Number of mortality centers 46

Douglas-fir Beetle
Total number of dead trees 183
Area of mortality 130 acres
Number of mortality centers 25

Pine Engraver Beetle
Total number of dead trees 603
Area of mortality 430 acres
Number of mortality centers 85

Western Pine Beetle
Total number of dead trees 54
Area of mortality 90 acres
Number of mortality centers 18

Spruce Beetle
Total number of dead trees 70
Area of mortality 50 acres
Number of mortality centers 10

Western Spruce Budworm defoliation:
Acres of light defoliation 290942
Acres of moderate defoliation 308422
Acres of heavy defoliation 186993
Total acres of defoliation 786357

Larch Casebearer defoliation:
Acres of light defoliation 252
Acres of moderate defoliation 0
Acres of heavy defoliation 0
Total acres of defoliation 252

Acres of Pine Butterfly defoliation = 2828

The consistancy of data summaries produced by the CAM/GIS system is far superior to those produced by hand. Data summaries produced manually for forests where abundant pest activity had occurred seldom can be computed twice with the same result. Summaries computed by the system outlined above are exactly the same and will not change unless the ADS map is redigitized or the summary program is modified to use different average values for the mortality centers.

Reproducing ADS data

Graphically reproducing digitized data on a base map (typically black line forest maps) is the final operation in preparing annual survey data for each unit land manager. Normally graphics information is reproduced on 3/8 in per mi base maps however, maps of almost any scale can be used providing that two map section corners necessary for setting reference points can be located. Data has been accurately plotted on maps with scales ranging from 2.6 in per mi on 7-1/2 min quadrangle maps to page size regional maps scaled at 80 mi per in.

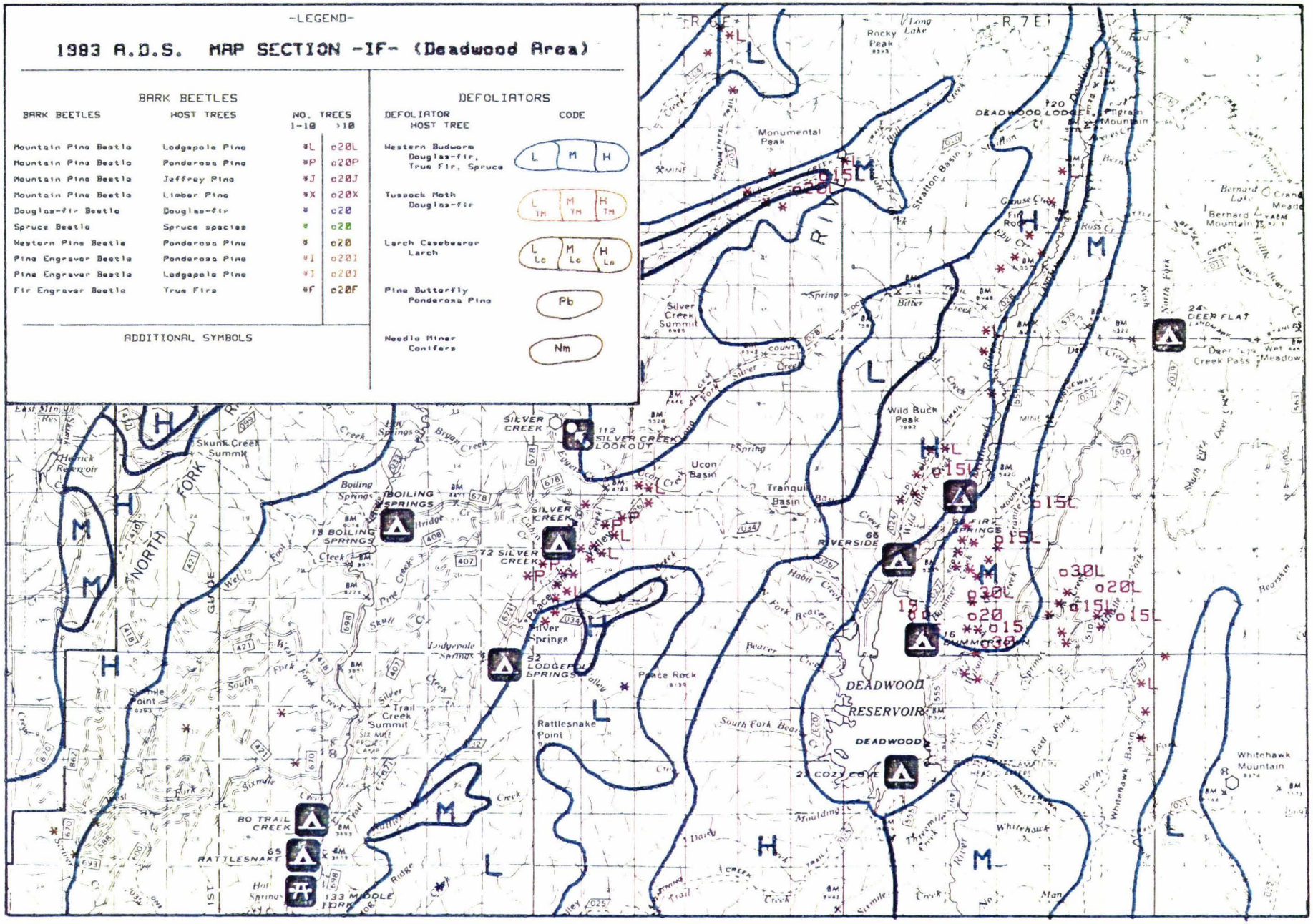
To reproduce graphics information, the desired base map is selected and placed on the plotter with two map section corners being set as reference points. The plotting program is then activated and the operator is asked to identify the survey year, number of vertical and horizonal map sections and alpha characters of the map section occuring in the northwest corner. One to sixteen forest names may be entered allowing a regional map of pest information to be plotted. Plotting information for all forests on one map such as on a regional or a state map is simplified by entering a keyword such as "REGION" or "IDAHO". When one of these keywords is entered instead of a forest name, the program will automatically plot information for desired forests. If only one forest is of interest, the number and identity of districts of interest will be requested, allowing selection of one or more districts.

Information may be plotted for a single pest, a group of pests, or all pests for which data is available. For example, a map can be produced for a group of defoliators, one specific defoliator, or even one intensity of defoliation for a specific pest.

When the desired information has been keyed into the program, the proposed map may be displayed on the CRT prior to reproduction. However, unless there is reason to preview the pest data, this step is usually skipped and the map is plotted directly on the HP-7580B plotter. Color-coded information with appropriate symbols and labels is then reproduced on the base map (Figure 4).

Map legends (Figure 4) can be printed directly on the base map by the plotter if desired. To do this the operator selects and digitizes the location for the legend then enters a map title on the CPU keyboard. The program will completely letter the entire legend and place color coded symbols for the various pests in the area defined by the operator. Preprinted legends may also be placed on the map and the program will letter the heading and the color coded symbols for each pest saving about 4-5 minutes per map.

Figure 4 - - COMPUTER REPRODUCED 1983 AERIAL DETECTION SURVEY MAP
AND STANDARD LEGEND FOR MAP SECTION -IF-



Digitizing data requires no more time than previously required to summarize data manually, however, once digitized, copies of data and graphics information may be prepared in a fraction of the time previously required. Entire forest summaries, printed in a format that can be sent directly to land managers, are completed in two or three minutes compared to hours of hand calculating and manually typing tables. Copies of individual forest maps which take approximately 4 hours per copy to prepare manually on a light table, are now reproduced in 30 minutes or less.

Dissemination of information

After preparing data summaries and maps, pest information is quickly disseminated to users. Recently we have developed a standardized table of information which along with maps and data summaries are sent to each forest supervisor and ranger district office in southern Idaho. For each pest identified during the ADS, location, host(s), trees per acre affected, outbreak area, trend and management considerations are addressed in the information table (Figure 5).

USE OF ADS INFORMATION

Current ADS information provides land managers with locations and estimates of recent pest-caused tree injury. This information is used to: plan and prioritize timber salvage and firewood sales; prepare and revise environmental assesments or environmental impact statements; provide background input to forest plans; update timber inventory data when insect infestations become catastrophic; and plan suppression activites.

Historical pest information provides a valuable tool for use in evaluating effects of previous management activities, preparing risk rating models using site and stand characteristics, partitioning damage for survey purposes and in modeling outbreak development.

To utilize historical pest information we have developed additional programs to compare and combine data by geographical location. This capability gives it the added power of a GIS. An example of the usefulness of this graphics feature was illustrated during a recent western spruce budworm evaluation for which it was necessary to summarize, stratify, and plot the total years and intensity of western spruce budworm defoliation on the Boise and Payette National Forests from 1967 to 1983 on one map. This information was required to stratify the forests for an ecomomic analysis of the impacts due to defoliation (Beveridge 1984). Whereas several complete color maps were prepared with this system in two days, three weeks were required to prepare one similar map of just the Payette N.F. for a 1977 analysis (Ollieu 1977).

The program which creates historical overlays operates much like the plotting program except that pest data is converted to a grid system prior to plotting. Each map section is divided into 6300 grid cells each representing a specific ground location. Each cell is assigned a value determined by defoliation

Figure 5 - - SUMMARY OF AERIAL DETECTION SURVEY INFORMATION WITH MANAGEMENT CONSIDERATIONS AS SUBMITTED TO LAND MANAGERS

Boise Forest | Cascade (D-4) District | 1984 Year

Forest Pest Activity as Determined by Aerial Detection Survey

Forest Pest[1]	Location	Host	Trees or Acres	Trend	Management Considerations
DFB					No significant activity observed.
IPS (Ips pini)	Crown Pt. area	LP/PP	126 Trees	Up	1) Population builds in PP slash or follows attacks by western and mountain pine beetles. 2) May cause top-kill of mature and over-mature pine at appropriate diameter. 3) Units scheduled for overstory removal, and have a residual stand of predominantly PP, may require special contract clause C6.415, "Protection from Ips Buildup."
MPB	Warm Lake area So. Fk. Salmon River Clear Cr. Big Cr.	LP/PP	9,628 Trees	Up	1) Infestations often persist until the majority of susceptible host is killed. 2) Stand species diversity may be altered. 3) Dwarf mistletoe infections, if present in the stands, may be aggravated. 4) It is best to not delay harvest beyond the age where current annual increment equals mean annual increment. 5) Maximum stand species diversity will prevent total stand loss. 6) It is best to break continuous LPP forests into smaller blocks of different ages and size classes.

Boise Forest | Cascade (D-4) District | 1984 Year

Forest Pest Activity as Determined by Aerial Detection Survey

Forest Pest[1]	Location	Host	Trees or Acres	Trend	Management Considerations
PBF	Crown Pt.	PP	2,828 Acres	Down	1) Larvae feed upon and defoliate 2-3 year old needles, causing loss of vigor. 2) Bark beetles may ultimately kill mature trees of low vigor.
LCB	West Mtns.	L	252 Acres	Down	1) Growth loss and mortality can occur during prolonged infestations. 2) Biological control with a parasitic wasp, Agathis pumila reduces Larch Casebearer populations. 3) No effective, enonomical chemical control is known at present.
WSB	District wide	DF,GF,SF, S	166,987 Acres(Total) 154,415 (Light) 11,444 (Moderate) 1,128 (Heavy)	Down	1) Heavy infestations usually last 7-12 years. Overstory hosts may be top-killed and understory trees killed. 2) Cone crop losses may retard natural regeneration. 3) Dead tops and branches resulting from defoliation serve as entry courts for decay fungi. 4) Even-aged stand structure and reduction of host component alleviate impacts of budworm.

[1] DFB - Douglas-fir beetle
FEB - fir engraver beetle
IPS - IPS species (pine engraver beetle)
LCB - larch casebearer
MPB - mountain pine beetle
NM - needle miner
PBF - pine butterfly
SB - spruce beetle
TM - tussock moth
WPB - western pine beetle
WSB - western spruce budworm

[2] DF - Douglas-fir
GF - grand fir
LP - lodgepole pine
PP - ponderosa pine
SF - subalpine fir
S - spruce

intensity or the number of faders per acre in the area. Cell size will vary depending on the ground area of the original map section digitized, however, most cells will be 40 to 45 acres in size for the standard map sections used by this system. For some special projects where the standard map sections were not used and information was digitized from either the north or south half of a 7-1/2 min quadrangle map cells have an area of about 2.5 acres each.

For historical overlays, one pest is analyzed at a time. Annual survey data for a specified pest and area is located, converted to annual grid matrices, and stored on a mass storage device. All annual survey data is first converted to annual grid matrices which are then combined or compared prior to stratifing and plotting.

Creation and plotting of a specific map is accomplished by the program using operator supplied criteria and the stored grid data. Since pest data are stored in the annual grid matrix by intensity for defoliators and as trees per acre for mortality centers, the operator has the option of graphically comparing or summarizing outbreak intensity or pest occurrence for varying time periods. In this way composite maps showing intensity over time (Figure 6) or the total number of years a pest has occurred in an area can be created for various time periods. Other types of comparisons which can be graphically displayed are changes in outbreak area for two consecutive years or two groups of years ie. two outbreaks. As the information is plotted area of each stratum can be calculated and printed upon completion of the map if desired.

The number of stratifications to be plotted are totally optional and are determined just prior to actually plotting the information. If the operator desires, the program will preview the compiled grid matrices and determine the range of values as well as the number of cells with each value in the proposed map. This information will then be printed allowing the operator to better determine the number of strata to plot and the range of values each should encompass. These strata can be selected by the operator who not only chooses the range of values, but the pen color and line pattern for each strata as well.

Composite overlays of graphic information which have been prepared by this system include:

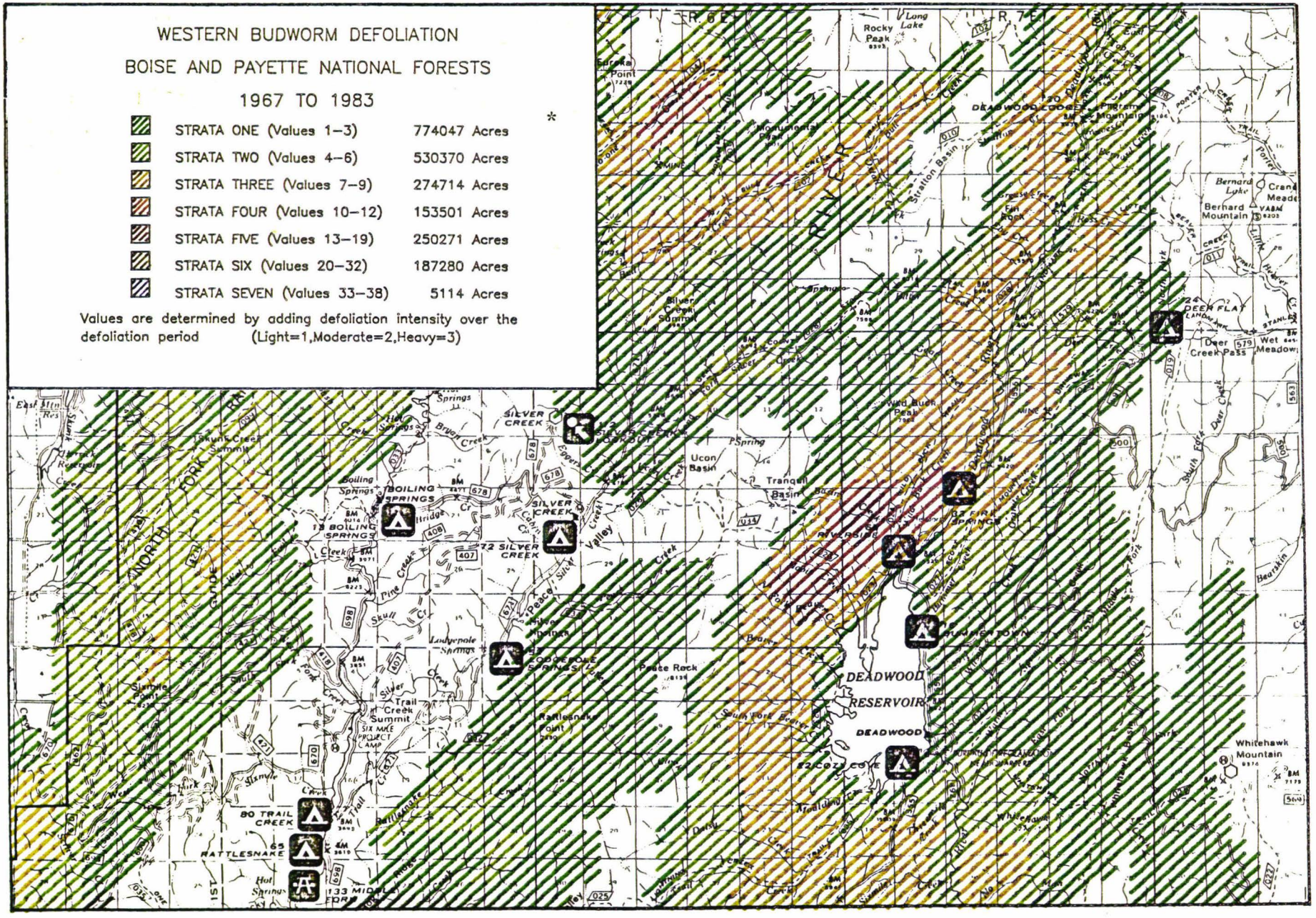
Defoliation overlays
- -Several years of occurrence of a specific pest
- -Cummulative intensity over time; assigning a value (1-3) for annual defoliation intensity and adding these values together

Tree mortality overlays
- -Number of years of occurrence of a specific pest
- -Cummulative mortality in trees per acre over time

Locate common areas between two or more layers
- -Locate common areas between two years of infestation
- -Locate common areas between two groups of years ie. outbreak 1 and outbreak 2

Comparison of dissimilar data layers ie. soil, habitat & slope
- -Stratify up to four layers with different data types in each
- -Tally acres of different strata by stand number

Figure 6 - - EXAMPLE OF HISTORICAL OVERLAY FOR 17 YEARS OF WESTERN SPRUCE BUDWORM DEFOLIATION PRODUCED BY ADDING ANNUAL DEFOLIATION INTENSITY FOR THE OUTBREAK PERIOD



* Acres given are for the entire two forest area

Modifications to the historical overlay program, which allow it to function more fully as a GIS, are developed and are being tested. These modifications allow the comparison of pest and/or non-pest information e.g. soil, forest, or habitat types and the subsequent partitioning of areas having certain characteristics. Areas having specified characteristics are located and plotted and area is calculated.

Currently reporting vegetation injury by ownership is accomplished by plotting the data on a base map where ownership is displayed. Vegetation injury on lands other than those administered by the forest service are then calculated by manual methods. We hope to soon convert land ownership data to a grid matrix which can then be used to summarize injury by land ownership during the summarization process.

DISCLAIMER STATEMENT

The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others which may be suitable.

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APPENDIX

PEST - Starter program loads soft key file and sets mass storage device

PEST01 - Digitizing program, will digitize ADS or other types of map information

PEST02 - Data summary program, totals ADS information and outputs results

PEST03 - Plotting program, will plot data on the HP-7580B or HP-9872A plotters

PEST04 - CRT plot program, will display digitized data graphically on the CRT

PEST05 - Data storage program, stores digitized or edited data files

PEST06 - Edit program, recalls and displays data files on the CRT for editing

PEST07 - Converts X,Y coord. data to grid data for overlay program options 1-3

PEST08 - Plots and stratifies grid data created by PEST07 options 1-3

PEST09 - Data file packing program, removes deleted data from data files

PEST10 - Draws map section lines on ADS maps proir to digitizing or editing

PEST11 - Grid data edit program, corrects errors in grid data files

PEST12 - Creates grid data files for option 4 of the overlay program

PEST13 - Plots grid data files created by option 4 of the overlay program